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(21) International Application Number: PCT/BE97/00036 (22) International Filing Date: 14 March 1997 (14.03.97) (30) Priority Data: 9600237 18 March 1996 (18.03.96) BE (71)(72) Applicants and Inventors: MASSON, Jean-Pierre [BE/BE]; Nieuwelaan 125, B-1853 Strombeek-Bever (BE). STRUYS, Michel [BE/BE]; Keizervest 85, B-9000 Gent (BE). DE SMET, Tom [BE/BE]; Stijn-Streuvelslaan 16, B-9111 Belsele (BE). (74) Agents: VAN CUTSEM, Paul et al.; Bureau Vander Haeghen S.A., Rue Colonel Bourg 108A, B-1030 Brussels (BE).		(81) Designated States: CA, CN, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments. In English translation (filed in Dutch).</i>
(54) Title: APPARATUS FOR CONTROLLING AN INTRAVENOUS INJECTION (57) Abstract An apparatus for controlling a computer-assisted intravenous injection of a medicine solution to be administered with the aid of a standard injection pump is similar to an anaesthetic machine with which anaesthetists have been familiar for a long time now, if it comprises a calibrated encoder unit, in particular a rotary knob (1), in combination with concentration regulation based on a pharmacological model. By means of said calibrated rotary knob (1) the anaesthetist is able to set a variable desired value to carry out a parameterized injection. The apparatus also comprises at least one additional rotary knob (2, 3) or push-button, by means of which some patient parameters can be sent to a particular model in order thus to set the patient-dependent characteristics of the above-mentioned pharmacokinetic model.		

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APPARATUS FOR CONTROLLING
AN INTRAVENOUS INJECTION

Background of the invention

5 The present invention relates to an apparatus for controlling a computer-assisted and pharmacokinetics-based intravenous injection, of a medicine solution to be administered, with the aid of a standard injection pump.

10 An injection pump is a device to which a syringe is fitted which is filled with a liquid, in particular with a medicine solution. For a medicine solution to be administered, the piston of the syringe is pushed forward with the aid of a time-delay drive system which moves in an axial direction with respect to the installed pump. In general, an injection pump can be described as a metering
15 device, by which a medicine solution is administered with great precision and over a certain period from a syringe, sachet or some other package. In the process, the injection rate can be selected and controlled by a constant speed being set at the injection pump or by means of a
20 computer interface. In recent times, intravenous medicine solutions have in practice increasingly been administered by means of pumps comprising a substantially constant controlled speed regulator. In particular, these find increasing use in anaesthetics.

25 The purpose of anaesthesia is to put a patient into a state of analgesia and amnesia, to maintain vital functions during the operation and to ensure ideal operating conditions for the surgeon. Modern anaesthesiology achieves this objective by making use of
30 strong inhalation gases and/or intravenous anaesthetics.

Rapidly evanescent inhalation gases are usually employed for maintaining anaesthesia. They are administered by means of an evaporator in an open or closed circuit. The concentration can be easily regulated since,
35 given the small amount of soluble agents, a rapid equilibrium is established between the inhaled gas concentration and the blood level. The most popular anaesthetic machine comprises an evaporation chamber which is brought

to room temperature and in which a completely saturated vapour is produced which is diluted afterwards with carrier gas. The supply line to the patient is fitted with an oximeter and a valve to prevent excess pressure.

5 The concentration of inhalation gases is limited to what is necessary and is titrated in accordance with the patient's response. The titration is effected with the aid of a calibrated knob. The inconveniences suffered by a patient as a result of anaesthesia by means of

10 inhalation gases are the wearing of a mask or an intubation and the risk of bronchospasms.

The intravenous administration of strong anaesthetics is being increasingly preferred to the administration of inhalation gases. In clinical applications,

15 the method has numerous advantages. It is usually readily accepted by the patient and is relatively convenient for the practising anaesthetist. However, in contrast to the inhalation gases whose concentration can be quickly adjusted in the brain and cardiac tissues by changing the titration, no practical methods exist for the

20 neutralization or elimination of intravenous anaesthetics. The end of the pharmacological effect occurs solely by redistribution, metabolism and excretion. Regulating intravenous anaesthesia will

25 therefore require strict consideration of the weight, the gender, the age and the general state of the patient. The major problem of manual regulation of an injection pump for intravenous anaesthetics continues to reside in the adequate administration schedules which require a considerable computational effort to take into account specific

30 patient data with respect to intake, distribution and elimination of the product. Many doctors are therefore averse to using these machines and techniques.

In contrast to these manually controlled

35 injection systems, computer-assisted and controlled injection systems make use of a form of an electronic instrument which is connected to a standard injection pump. This control unit is able to regulate adjustments to the relationship between dose and injection rate,

without the intervention of the user. These control systems are programmed with pharmacokinetic models, to assist with the intravenous administration of the medicine.

5 Pharmacokinetics is a subdivision of pharmacology, which studies the action of medicaments in the living organism. It is engaged in the study of the disposition, in other words the distribution and the elimination of a medicine in the body. Since the human
10 physiological model is far too complicated to be incorporated in a computer program, the description of the behaviour of a medicine requires theoretical compartmentalized models. Various scientific publications prove the accuracy of the pharmacokinetic compartmentalized models which are based on weight and age and
15 which are derived from kinetic studies on the population.

 If a computer or another type of processor is used to calculate a schematic dosage, this results in a computer-assisted and a pharmacokinetically based injection system for administering medicaments. These systems
20 have been used for some years now in the form of computer programs in minicomputers or desktop computers. Thanks to these computer programs, the user is able to set and to maintain a specific desired blood level or other
25 parameters, in order thus to achieve a specific effect. The operation of such a program for regulating an injection pump proceeds as follows: after the patient-dependent parameters, i.e. weight and age, have been set, the controller calculates the required injection rate to
30 achieve and maintain the concentration set by the user. It follows therefrom that all the necessary parameters are input with the aid of a keyboard. The drawbacks of this system are the large amount of equipment required for controlling the system, and the dependence on electricity, resulting in immobility of the system. Some controllers have been developed where the user can set the
35 necessary parameters via multifunctional rotary knobs and menus. Since these complicated systems are impractical to use and are still far removed from known clinical prac-

tice, the systems existing hitherto remained limited to experimental scientific models.

Document DE-A-4320365 by Drägerwerk AG discloses a regulating apparatus which is able to operate different syringe pumps. This apparatus is programmable with the following parameters: the weight of the patient and dosage per unit time per kg of body weight. This apparatus then calculates the product dosage to be administered in ml per hour, as described in sections 5 and 6 of the text. This apparatus is not capable of automatically adjusting the dosage of a medicamentous fluid to the physiological stresses of the patient and therefore only provides a constant controlled flow rate. Consequently, this system takes no account of the pharmacological needs of the patient. As a result thereof, there is a risk of accumulation, over- or underdosing over time. Dosage adjustments during an ongoing procedure can be instituted only manually.

Moreover, express reference is made, for example in document EP-A-0364010 by Bard, to a constant flow rate, and use is made of a manually preset flow rate which is not, however, automatically adjustable during the infusion period. In this document, the various multifunctional rotary knobs are used for inputting various patient-dependent rotary parameters and other parameters such as the dimension of the syringe, duration of the injection and interval between two successive doses, where the corresponding calibrated rotary knob is lacking.

The document EP-A-0497041 depicts a rotary knob in Fig. 9, which does not constitute a calibrated rotary knob, but a rotary switch.

The technical problem of the automatically adjustable amount of intravenous medicamentous fluid in accordance with the pharmacological stresses of the patient renders the invention fundamentally different from the above-cited documents.

The object of the invention is to provide an attractive and reliable solution to the problem of

metering the adjusted amount of intravenous medicamentous fluid as a function of the patient's response.

The system offers the advantage that the use of a standard injection pump will be revalued, an optimum
5 metering strategy being employed and, in a very simple manner, use being made of a technique known to anaesthetists for many years now.

For many years, anaesthetists were used to metering the required amount of anaesthetics by simply
10 turning a convenient calibrated rotary knob. Given the widespread use of the classic anaesthetic apparatus with evaporator, the system has become routine to any anaesthetist.

To achieve this object, the invention proposes an
15 apparatus as described in the preamble of the main claim. To this end, the apparatus comprises a calibrated rotary knob.

The present invention intends to overcome the abovementioned problems and drawbacks. To this end, the
20 system according to the invention is remarkable in that it comprises a calibrated encoding means, especially of the type of a rotary knob, which is able to adopt various positions with a unique value in each position and a rest state in each position, by means of which a user is able
25 to set a variable desired value to carry out a parameterized injection, and also at least one additional encoding means, especially of the rotary knob or push-button type, by means of which a few parameters of the patient can be transmitted to a specific model, in order thus to set the
30 patient-dependent characteristics of the pharmacokinetic model.

Reverting to said document DE-A-4320365, the latter leaves the choice between an automatically regulated intravenous administration with the aid of a
35 programmed injection pump and manual operation with the aid of a calibrated rotary knob, but it does not allow for any adjustment of the automatic regulation.

The regulating apparatus does not, according to the invention, operate in accordance with the principle

of constant flow rate administration of a medicamentous fluid per unit time, but in accordance with the principle of keeping constant a desired concentration of a medicamentous fluid in the blood or in another theoretical
5 bodily compartment or model. To achieve this object, the apparatus according to the invention is equipped with a sophisticated pharmacological model, specifically dependent on the characteristics of the medicamentous fluid to be administered and on the specific characteristics of
10 the patient. After the patient-specific data have been set, the said apparatus is able to keep constant a specific concentration of said medicamentous fluid in a specific bodily compartment. In order to keep this concentration constant, the apparatus is able to allow
15 the pump rate to vary in accordance with the pharmacological result of the computer algorithms. In that respect, the invention differs fundamentally from the abovementioned documents.

The fact is that the existing sophisticated
20 pharmacological models and the simple way of operating it form essential aspects of the system. Applying a pharmacological model enables the user to set a concentration instead of a flow rate. Inhalation anaesthesia, which has been known for a long time, likewise involves concentra-
25 tions, as is inherent to the way it is administered. There is an essential difference between this and the administration on the basis of controlled flow rate. Linking concentration regulation to a calibrated rotary knob, identical to the one used with inhalation anaes-
30 thesia, provides a perfectly recognizable system and mode of operation to somebody who has used inhalation anaesthesia for years. This is another reason why rotary knobs for maintaining set desired values and the like have been omitted in the first instance. Inhalation anaesthesia
35 does not normally employ them either.

The invention moreover also consists in the convenient regulating system of a classic evaporator being copied across to the electronic regulating system of an injection pump, in other words the incorporation of

the popular convenient calibrated rotary knob, to enable titration control of the anaesthetics for an injection pump.

5 The presence of at least one additional rotary knob, which is not found in the classic evaporator, solves the problem of the combination of a pharmacokinetics-based standard injection pump controller and a large metering rotary knob. The simplicity of the method will encourage anaesthetists to use more intravenous anaesthetics.
10

Some older standard injection pumps likewise employ one or more small rotary knobs for setting the injection rate, albeit without further calculations.

15 Further particulars and features of the apparatus according to the invention are defined in the subclaims.

Further details and advantages of the invention will emerge in the detailed description, with reference to the accompanying drawings which, by way of example and not in a limiting sense, illustrate an embodiment of the
20 invention.

In these drawings,

- **Figure 1** shows a perspective side view of the machine according to the invention;
- **Figure 2** shows a mirror image of the machine
25 depicted in Figure 1;
- **Figure 3** shows a functional diagram of the machine depicted in Figure 1;
- **Figure 4** shows a block diagram of the machine depicted in Figures 1 and 2.

30 In these drawings, identical reference symbols indicate identical or similar elements.

As depicted in Figure 1, the apparatus for controlling a computer-assisted and pharmacokinetics-based intravenous injection, of a medicine solution to be
35 administered, with the aid of a standard injection pump according to the invention comprises a housing with a number of rotary knobs 1, 2, 3, a display 4, 5, 6 and an interface 7 to connect the system to the injection pump to be controlled. An on/off switch 8 and an input for the

supply voltage are also provided. An internal micro-controller regulates the system and carries out the required calculations. The rotary knobs are used for inputting the various data, i.e. patient-dependent parameters and the desired value for the concentration to be regulated.

The apparatus has been developed for the purpose of regulating, on the basis of a pharmacokinetic model of the medicine to be administered, a standard injection pump. To ensure optimum convenience of use, a number of displays and rotary knobs, limited to the absolute minimum, are required in order for the system to be adequately operable. At the same time, it was attempted to retain as far as possible, by electronic means, the similarity with the evaporators with which most anaesthetists are familiar with.

The system is constructed as an independent, portable system which is able to regulate various types of standard injection pumps which are provided with a computer interface.

The various components of the system are described hereinafter in more detail.

The user is able to set the desired concentration of the administered medicine in the patient by means of a large calibrated rotary knob 1, which is arranged on top of the housing, in precisely the same way as with an evaporator. The rotational position of the rotary knob is converted with the aid of a single-turn analog potentiometer and is permanently being read by the internal microcontroller. This method was chosen, since a single-turn analog potentiometer has a unique value in each position. This allows a graduated scale to be applied to the rotary knob, in analogy with the evaporator, which makes it much simpler for the user to select a desired value.

In the case of a system having an analog rotary knob, the process of reading in the desired values does in some respects differ fundamentally from a system with push-buttons. If push-buttons are used, it is simple to

detect when a new desired value is input. A system having a rotary knob, however, must deduce by itself when a value read in represents a new desired value of the user. To solve this problem, two analog potentiometers, which
5 are read out independently, are connected to the rotary knob 1. The values obtained are compared and their average is calculated and is fed through a digital low-pass filter with hysteresis. This has the following advantages:

- 10 - the effect of averaging, hysteresis and low-pass filter is to limit the influence of electric and discretization noise which is inherent in discretization of an analog potentiometer. Said noise could cause rapid, small fluctuations in the
15 desired value;
- an alarm can be ignored in the event of failure of the coding of the potentiometers and thus of the desired value.

Moreover, convenient operation requires adequate
20 protection against inadvertent alterations, e.g. while the patient is being moved. A zero-position lock is therefore fitted, which prevents the user from accidentally initiating anaesthesia. In addition, the user is able to lock the rotary knob 1 mechanically at each
25 selected desired value, with the aid of a brake. Finally, an electronic interlock prevents the system from being started as long as the desired value set differs from zero, since that would immediately start the injection when the system is switched on. The error is pointed out
30 to the user by the system, should this situation occur.

In addition to the large rotary knob 1, two or three smaller rotary knobs 2, 3 are provided for the input of characteristics such as weight, age, ... or another patient characteristic for the benefit of the
35 pharmacokinetic model. The rotary knobs are connected to a digital encoder and are likewise read by means of the internal microcontroller. Since these values must be set before anaesthesia commences, an electronic safeguard has been added which prevents changes during anaesthesia.

The internal microcontroller is programmed with the single or multiple pharmacological model of the administered medicine. It permanently reads the desired value for the blood level of the medicine in the patient, set by means of the said rotary knob. At fixed intervals, or when the desired value was changed, the microcontroller estimates the injection rate required to attain the desired value, and imposes said rate on the pump. This estimate is based on the pharmacological model of the medicine and on the administered amount, according to the pump response. Since the system scans the pump for the administered volume, it is able to detect any change in the syringe, the uncoupling of the pump or the stopping of the injection in whatever manner, and to keep calculating the concentration, taking into account that the pump is not running. From the moment the pump is once more ready for injection, the system will again implement the desired value.

The appliance can be switched off only by the on/off push-button being pressed for a sufficiently long time, to avoid accidental switch-off. An audible alarm is generated when the push-button is pressed. Various other states (almost empty battery, pump not connected, ...) likewise generate a visible and audible alarm.

The displays in various colours 4, 5, 6 are used solely for indicating the variables set and the actual concentration, exactly like the necessary alarms. They are chosen to be large enough to ensure clear visibility.

If the pump is connected to the system while the administered volume indicated by the pump differs from zero (e.g. because the pump remained switched on after the previous injection), the system will automatically adjust the reference value of the administered volume, as if nothing has as yet been administered by the pump.

Since there is a loss of precision with some pumps, if the injection rate is adjusted too frequently, the system will adjust the injection rate at fixed intervals or when the desired value is changed. Fluctuation of the desired value owing to noise is prevented,

moreover.

In the event of a power cut-off, the system switches over automatically to an internal battery. This makes the appliance autonomous for at least two hours.

5 Thanks to the small dimensions, the appliance can be carried along together with the pump, when the patient is being moved, without the injection being interrupted.

Installation of the rotary knob for setting the desired value and of other rotary knobs is not limited to
10 the abovementioned location. The rotary knob need not even be mechanically secured and can be installed externally or hand-held and connected to the system in some other way. Irrespective of whether an analog potentiometer or digital encoder is chosen, the setting
15 of the various rotary knobs can be coded for the system in whatever manner, whether it be electrically, electronically, magnetically, optically, with the aid of an analog or digital encoder or potentiometer.

The internal microcontroller of the system is
20 able to carry out the calculations in conjunction with any singly or multiply compartmentalized pharmacological model for whatever medicine to be administered. Thus the invention can be used, without essential adjustments, for controlling an injection pump which administers any type
25 of anaesthetic, hypnotic, opioid, muscle relaxant or cardiovascular medicament, vasopressor or vasodilator, as long as the system is provided with the correct model for said medicament. If new parameters are derived for a new medicine, the system according to the invention can be
30 adapted in a simple manner so as to regulate a standard pump to administer said medicine. The manner in which the data of a particular medicine are input, whether by the user, by means of an arbitrary manually or electronically input code or any combination of such methods, is not
35 essential in this context. Any such change involves nothing more than the adjustment of calculations and/or numerical variables and is within the scope of the appended claims.

Until now, the blood level has continually been

mentioned as the variable to be regulated. However, the system is not restricted to this. Any variable which can be regulated by a particular injection regime being employed can be regulated with the apparatus according to the invention, since this, too, is only a question of adapting the calculations.

Any type of injection pump provided with a computer interface can be regulated, as soon as the apparatus has been adapted to the communication protocol used. This is only a question of time. In this context, an injection pump is described as any type of device which can be used to administer medicine, packaged in a syringe, bag, ... at an accurately controllable rate over an extended period, said rate being adjustable with the aid of a computer interface.

By extension of the previous point, any system which is able to automatically detect a connected pump and to adjust thereto, again does not differ essentially from the system, since it is technically possible to derive the suitable protocol from the protocols for various injection devices.

Any system which combines various systems of ours or the said extensions in whatever manner, for example by combining one or more microcontrollers in one or more housings, which regulate a plurality of pumps with different medicines, is essentially no more than an alternative embodiment of the system.

CLAIMS

1. Apparatus for controlling a computer-assisted and pharmacokinetics-based intravenous injection, of a medicine solution to be administered, with the aid of a standard injection pump, characterized in that it comprises a calibrated encoding means (1) which is able to adopt various positions with a unique value in each position and a rest state in each position, by means of which a user is able to set a variable desired value to carry out a parameterized injection, and also at least one additional encoder (2, 3) or push-button, by means of which some parameters of the patient can be transmitted to a specific model, in order thus to set the patient-dependent characteristics of the abovementioned pharmacokinetic model.
2. Apparatus according to the preceding claim, characterized in that each said encoding means is formed by a calibrated rotary knob (1, 2, 3) which is limited to a single turn.
3. Apparatus according to the previous claim, characterized in that the abovementioned rotary knob (1) is provided with a lock in the zero setting, as well as with a brake so as to involve the user at any concentration.
4. Apparatus according to any one of the previous claims, characterized in that the movement of the said encoding means (1) is translated into a change of said desired value in an electrical, electronic, magnetic or optical manner, use being made of a single- or multiturn analog or digital encoder or potentiometer.
5. Apparatus according to any one of the preceding claims, characterized in that the said encoding means (1) is installed in an arbitrary location on the housing itself or not on the housing or is hand-held.
6. Apparatus according to the previous claim, characterized in that said encoding means (1) is connected to, or communicates with, the controller in a selectable manner.
7. Apparatus according to any one of the preceding

claims, characterized in that the internal microcontroller of the system is able to carry out the calculations which are associated with each singly or multiply compartmentalized pharmacological model.

5 8. Apparatus according to any one of the preceding claims, characterized in that it is suitable for driving various types of injection pumps provided with a computer interface (7), said type being selectable or not selectable by the user or wherein the presence of said type can
10 be automatically established by the system.

9. Apparatus according to any one of the preceding claims, characterized in that a model is input for another by means of a specific injection regime variable to be sent.

15 10. Apparatus according to Claim 9, provided with additional safety systems, namely: double encoding of the encoding means (1-3), stand-by voltage in the event of mains failure, protection against inadvertent changes of patient-specific model parameters, protection against
20 incorrect start-up, additional visible or audible alarms, protection against loss of control over the pump, inadvertent switch-off of the system, or incorrect adjustment of the concentration if the administered pump volume differs from zero when the system is switched on.

25 11. Apparatus according to any one of the preceding claims, characterized in that it comprises a display unit for representing the data, in particular internal data of said controller.

12. Apparatus according to the previous claim,
30 characterized in that said display unit is formed by an LED display.

13. Apparatus according to Claim 11, characterized in that said display unit is formed by an LCD display.

14. System consisting of a combination of more than
35 one apparatus according to any one of the preceding claims, comprising one or more apparatuses in one or more housings, which regulate one or more injection pumps in order to administer a plurality of medicines.

15. Method for controlling a computer-assisted and

pharmacokinetics-based intravenous injection, of a medicine solution to be administered, with the aid of a standard injection pump, according to any one of the preceding claims, characterized in that the user is able to choose from various pharmacokinetic models, or in that an anaesthetic, hypnotic, opioid, muscle relaxant, vasopressor or vasodilator which is to be administered is manually or automatically adjustable.

16. Use of the apparatus defined according to any one of the previous claims for use in PCA (patient-controlled analgesia) in a closed-loop system or other advanced applications making use of the linkages of a calibrated turning knob with an open- or closed-loop model in order to make available to the user, in a manner as simple as possible, the principle of administering intravenous medicamentous fluids.

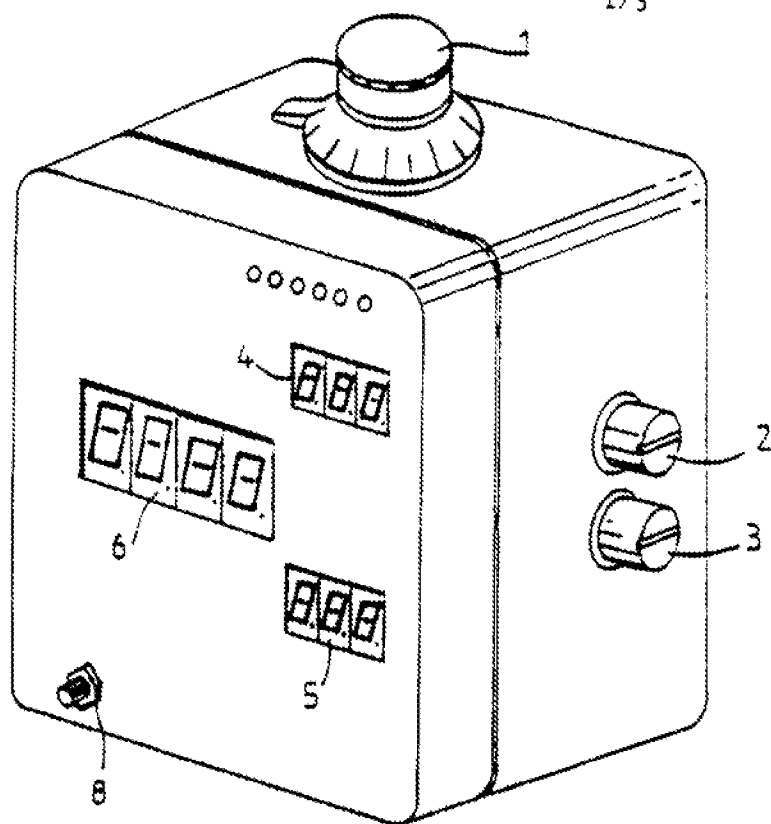


FIG. 1

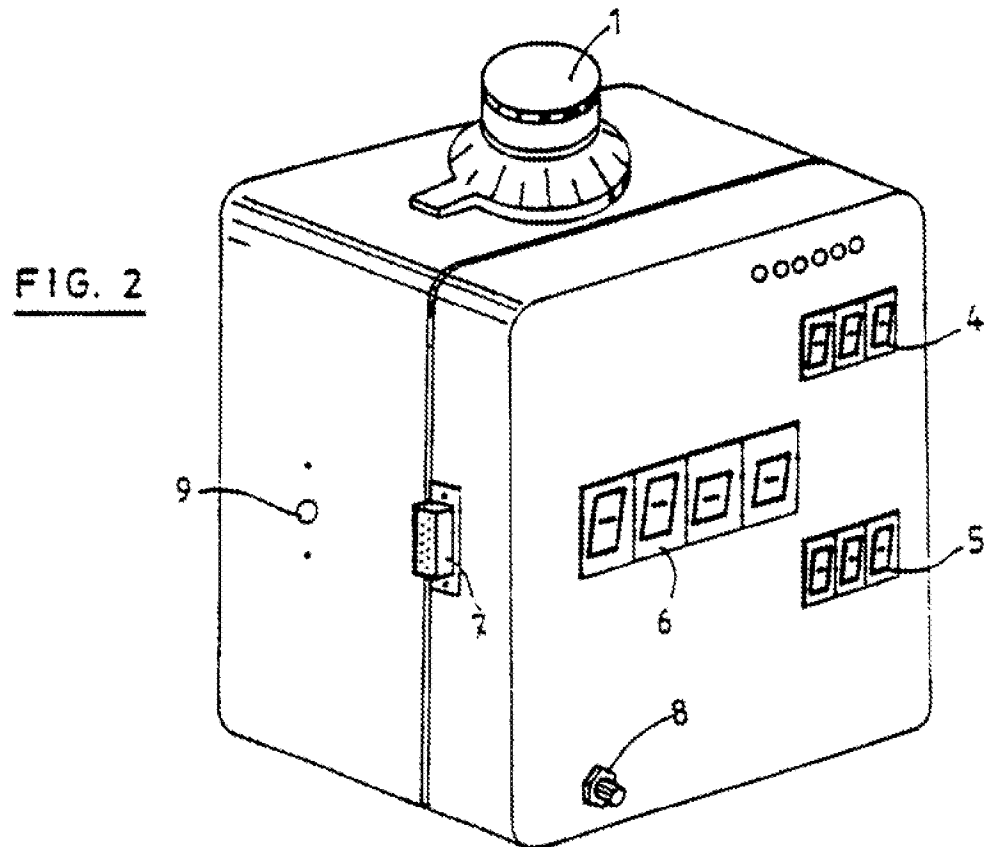


FIG. 2

FIG. 3

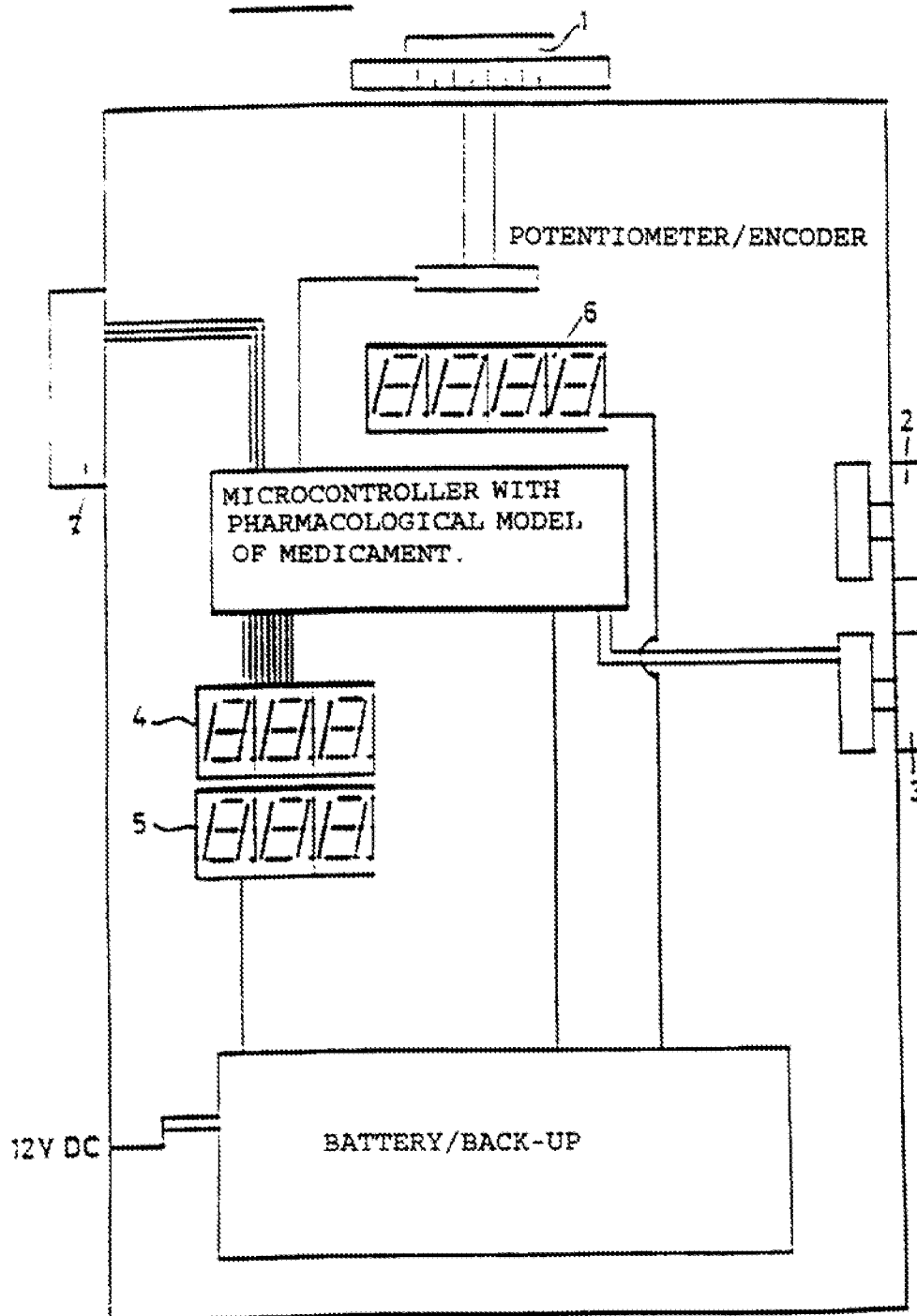
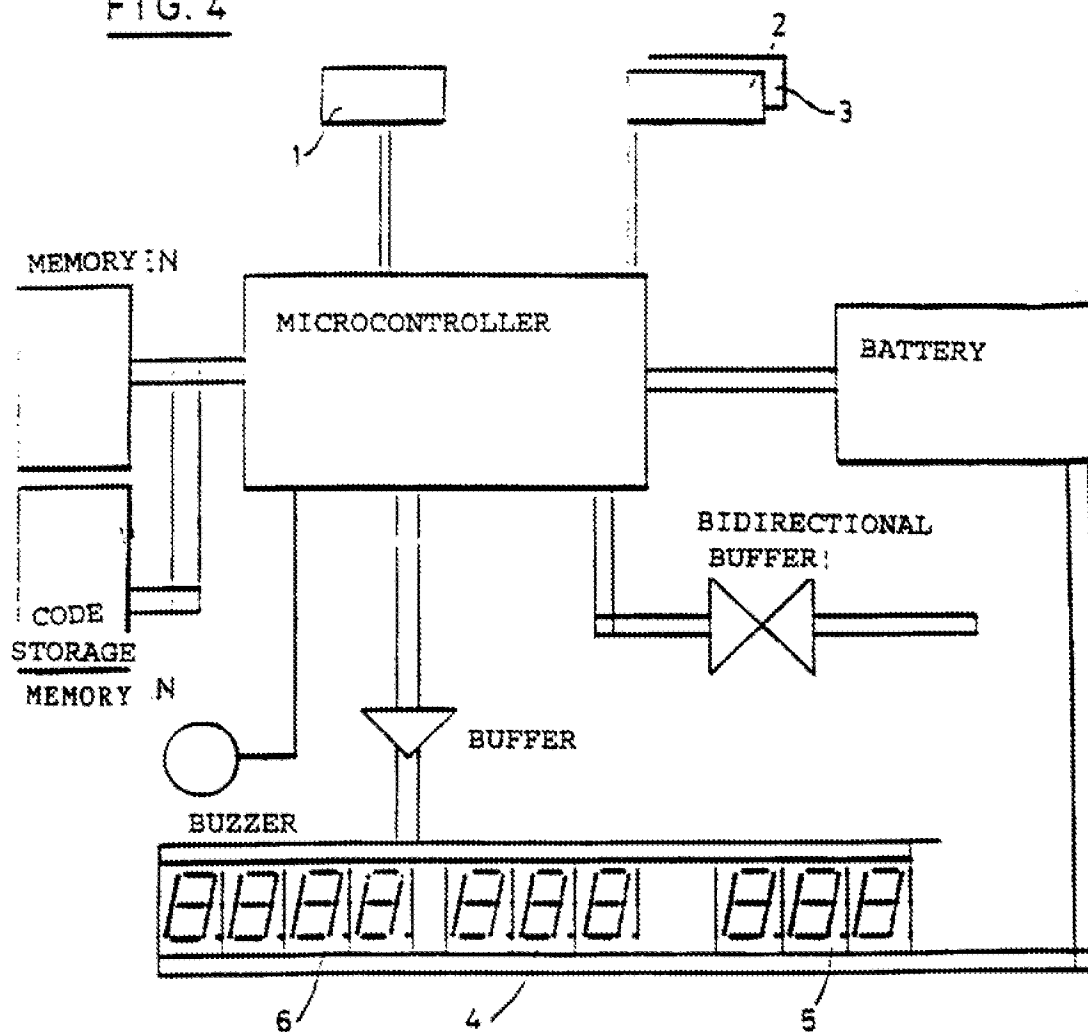


FIG. 4



INTERNATIONAL SEARCH REPORT

Int. onal Application No
PCT/BE 97/00036

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61M5/172

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 364 010 A (C.R.BARD, INC.) 18 April 1990 see column 4, line 1 - column 11, line 56 see figures 1-4	1-7,10, 15
X	EP 0 497 041 A (C.R.BARD, INC.) 5 August 1992 see column 5, line 27 - column 6, line 54 see figures 8,9	1,2, 9-11, 13-15
X	DE 43 20 365 A (DRÄGERWERK AG) 22 December 1994 see column 5, line 36 - column 8, line 43 see figures 1-4	1,2,4-9, 14,15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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Date of the actual completion of the international search

2 July 1997

Date of mailing of the international search report

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Name and mailing address of the ISA

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Authorized officer

Schönleben, J

INTERNATIONAL SEARCH REPORT

International application No.

PCT/BE 97/00036

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 16
because they relate to subject matter not required to be searched by this Authority, namely:
Please see Rule 39.1(iv) PCT.
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. l. Application No

PCT/BE 97/00036

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 364010 A	18-04-90	US 4943279 A	24-07-90
		AU 615988 B	17-10-91
		AU 3094689 A	05-04-90
		CA 1327498 A	08-03-94
		CN 1042659 A	06-06-90
		DE 68906115 T	02-12-93
		IE 64932 B	20-09-95
		JP 2146281 A	05-06-90

EP 497041 A	05-08-92	CA 2060151 A	01-08-92
		DE 69124083 D	20-02-97
		DE 69124083 T	15-05-97
		ES 2098333 T	01-05-97
		JP 6261942 A	20-09-94
		US 5256156 A	26-10-93
		US 5256157 A	26-10-93

DE 4320365 A	22-12-94	DE 9321077 U	14-12-95
		EP 0633035 A	11-01-95
		JP 7031865 A	03-02-95
		US 5507412 A	16-04-96
